ROOF COVERINGS for FARM BUILDINGS and THEIR REPAIR

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ROOFING is available in a variety of materials, ranging from colorful, long-lasting, rigid shingles to low-cost roll roofing suitable for small farm buildings. Since in protecting a building and its contents no part of a structure is of greater importance than the roof, this should be chosen with care, put on properly, and kept in good condition.

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ROOF COVERINGS FOR FARM BUILDINGS AND THEIR REPAIR

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Contents

ROOFS are depended upon to protect buildings and their contents from the effects of the weather. It is important, therefore, to keep them in good condition and to consider carefully the kind of covering suitable for each need—rigid shingles or bituminous, metal, or canvas roofings.

Roof repairing is too often neglected. Many small defects that could easily be repaired if the work were done promptly are permitted to cause damage to the interior of the building and to shorten the life of the roof itself.

TYPES OF ROOFING

RIGID SHINGLES

For rigid shingles various kinds of materials are formed into small rigid units featuring richness of color, durability, variety of pattern, or some special method of fastening to the roof. Clay shingles and tiles, cement shingles, molded-asbestos tile, and shingles of different kinds of metal are sometimes used. The types of rigid shingles most common to farm structures are of wood, slate, and asbestos cement.

[1] Acknowledgment is made of the valuable assistance given on the original manuscript by Max J. LaRock, formerly assistant architectural engineer, Division of Structures, Bureau of Agricultural Engineering.

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If of a durable species and properly laid, wood shingles will provide a satisfactory, attractive, and comparatively low-cost roof having considerable insulating value.

The best commercial wood shingles are No. 1,[3] all heart, all edge-grained, and strictly clear. Southern cypress, redwood, and the cedars are in the highly decay-resistant group; northern white pine and southern yellow pine are moderately decay-resistant. Edge-grain, all-heartwood shingles (fig. 1, *A*) should be used instead of flat grain (fig. 1, *B*) for permanent roofs, especially for dwellings, because they have less tendency to curl and split, lower shrinkage, and better weathering characteristics. The lower grades of wood shingles are not economical in the long run for either high- or low-cost houses. They are well adapted, however, to use on side walls and temporary buildings.

Nearly all shingles are produced in random widths and are packed in bundles 20 inches wide. Four of these bundles are known as a

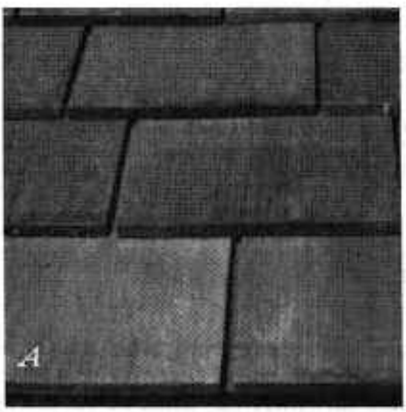

Figure 1.—*A*, Edge-grain shingles, readily identified by their "wire-grain" figure. No. 1 grade recognized in commercial standards admits only such shingles. *B*, Flat-grain shingles, the figure made up of comparatively wide irregular bands. Such shingles and those with varying amounts of sapwood are found in all grades below the No. 1 of commercial standards.

square. Each square of shingles, when applied at the standard roof exposure, will cover 100 square feet of roof area. A few dimensional-width shingles are produced in 5- and 6-inch widths and are generally used for special decorative effects on roofs and side walls.

Shingles are manufactured in lengths of 16, 18, and 24 inches, the majority being 16 inches. In laying them a definite length of the butt is exposed to the weather, depending on length of shingle and slope of roof. For roofs of one-fourth pitch[4] or steeper the standard weather exposure recommended is 5 inches for 16-inch shingles, 5½ for 18-inch, and 7½ for 24-inch. This will give three full layers of shingles at every point on the roof. On roofs of less than one-fourth pitch, the exposures should be reduced to 3¾, 4¼, and 5¾

[3] See grading rules of the lumber manufacturers' association that handles the species of wood desired, or commercial standard CS 31–38.

[4] The pitch of a roof is found by dividing the rise of a rafter by twice its horizontal run (table 5, p. 30).

inches for 16-, 18-, and 24-inch shingles, respectively, which produces a four-ply roof. It will be difficult to keep a shingle roof watertight if the slope is much less than one-fourth pitch.

The thickness of the 16-inch shingle is 5/2 (meaning that 5 butts will measure 2 inches in thickness); of the 18-inch, 5/2¼; and of the 24-inch, 4/2.

In warm humid climates wood shingles on new roofs are commonly nailed to slats (fig. 2), so as to permit ventilating the under side. Other advantages of the slat roof are its lightness and low cost. The slats should be 1- by 4-inch strips spaced apart the same distance as the weather exposure to be given shingles, so nailing can be done about 2 inches above the weather line of the shingles. In cold climates where a warm roof is needed, the shingles are ordinarily laid over tight board sheathing previously covered with rosin-sized building paper. Sometimes insulation board is used under slats in

Figure 2.—Laying wood shingles over slats.

place of the sheathing. The tight roof furnishes better insulation and permits less air to seep in.

Dry shingles should be spaced one-fourth of an inch apart and green or wet ones about one-eighth of an inch apart to allow for the swelling that occurs during damp weather. Each shingle should be fastened with two nails applied not more than three-fourths of an inch from the edges and 1 to 2 inches above the butt line of the next course. Threepenny rust-resistant nails are recommended for 16- and 18-inch shingles and fourpenny for 24-inch shingles. Driving nails into the middle may split a shingle or, if a too-wide shingle is used, atmospheric changes may crack it. It is, therefore, advisable to split wide shingles before laying them.

Joints should be broken at least 1½ inches, and all nails should be covered. Shingles should be doubled at all eaves and should project about an inch beyond the edge of the eaves. As the work progresses, the coursing should be checked to keep the shingle rows parallel with the eaves so as to avoid any great difference or unevenness in the exposure of the last few courses.

Figure 3.—Finishing hips and ridges. The popular Boston-type hip is built by selecting shingles of uniform width and alternately trimming and beveling each pair.

Methods of installing flashings are shown in the various illustrations. Details of finishing ridges and hips are clearly shown in figure 3. (For more complete discussion see pp. 24–27.)

When low-grade flat-grained shingles (fig. 1, *B*) are used to lessen the first cost of semipermanent structures, they will give greater service if laid with the bark side (that which was nearest the bark in the tree) exposed, as it weathers better than the heart side. Shingles so laid are not so likely to become waterlogged or to turn up at the butt.

The commonly used creosote stains [5] have little if any delaying effect on checking and very slight value in retarding decay. Their principal value is for decoration. After a short period of exposure there is little left but pigment. At this stage the shingles can be painted without danger of discoloration. Shingle stains rich in coal-tar creosote have much more preservative value than the light-colored ones that usually contain little if any of this oil. Shingles treated with coal-tar creosote only or with a stain containing any considerable percentage of this oil cannot be satisfactorily painted, as the creosote will bleed through the paint even after several years of exposure. Frequently only 6 inches of the butt ends are dipped in the stain before being laid, but it is better to dip them to within 3 inches of the tapered end. Although dipping is more effective than brush applications, brush coats are often applied for additional protection after the roofing has been exposed for several years.

Slate

Slates make an attractive durable roof covering and can be obtained in various colors. The best slates have a somewhat metallic appearance, do not absorb water, and are strong. While it is not feasible here to give the color and quality classifications of slate, a B–grade is reasonable in cost and has sufficient durability for farm structures.

Some dark slates will fade to a gray on exposure, and this may be unattractive, as the change is not always uniform. Certain green slates may become buff or brown after a few months' exposure, but the change is sometimes considered desirable, and it does not detract from the quality of the slate.

Certain sizes of slate are at times more plentiful than others, and some sizes usually cost more than others of the same grade. It will be economical, therefore, both in cost and time of delivery to permit the use of a range of sizes and random widths. Smaller sizes should be selected for smaller surfaces even when larger sizes are desired for the larger surfaces of the same building. The distance from the quarries influences the cost of slate—near the quarries the cost may be comparable with that of less durable roofings. Commercial sizes vary from 6 by 10 inches to 14 by 24. Slate three-sixteenths of an inch thick and 8 by 16, 9 by 12, or 9 by 18 is commonly used.

Holes for nails must be punched or drilled in slate, but machine punching is considered the best method. Both may be done on the site or at the quarry. The holes are made either at the head or to come half an inch above the head of the slate below, the distance

[5] See Farmers' Bulletin 1452, Painting on the Farm, pp. 19 and 32 for stains, and p. 11 for fireproofing paint.

from the end depending on length of slate and area exposed (fig. 21, p. 26). At the head in short slates the holes should be 1 inch from the top. They should be 1½ inches from the edges.

Slates are laid in much the same manner as are wood shingles, but as they weigh between 700 and 900 pounds per square [6] the roof framing for them should be stronger. On the main part of a house the roof should slope at least 6 and preferably 8 inches to 1 foot, though on porches or minor buildings the slates are sometimes laid on flatter slopes. If it is necessary to lay slates on house roofs at slopes of less than 6 inches per foot the lap should be increased. They should not be used on slopes of less than 4 inches per foot. Slates should preferably be laid on tight smooth-board sheathing (either plain or tongued and grooved) covered with 30-pound tarred or asphalt felt. Rosin-sized paper is not suitable.

Sometimes when insulation is not required, roofing slats, as described under wood shingles, are used instead of tight sheathing. Such slats should be a full 1 or 1¼ inches thick.

Each slate should lap that in the second course below by 3 inches and be fastened with two threepenny or fourpenny copper or other high-grade rust-resistant nails 1¼ to 1½ inches long. The nails should not be driven tight as there is danger of cracking the slates. Since the life of the roof depends on the fastenings it is poor economy to use nails that will not last. The slate should be doubled at the eaves, short slates being used, or the first course may be laid with the long side of the slate parallel to the eaves. The top courses at ridges and parts 2 feet from gutters and 1 foot from hips and valleys should be laid in elastic roofer's cement spread about one-fourth to three-eighths of an inch thick. The flashing should be 16-ounce soft copper, No. 9 zinc, or 3-pound hard lead. Hips and ridges are frequently finished "Boston style," which is similar to the shingling shown in figure 3.

Asbestos-Cement

Asbestos-cement shingles are made of asbestos fiber and portland cement under great pressure. They are durable and fire-resistant.

The natural color of this shingle is similar to portland cement and gives the roof surface a rather cold appearance. To meet architectural requirements, the shingles are now made in a wide variety of colors and surface textures. Color is produced by veneering the exposed surface, by incorporating mineral pigments throughout the body of the shingle, or by pressing fragments of colored slate or other materials into the exposed surface. There is no standard by which to judge the merits of the many variations, and the small buyer should be guided by the reputation of the manufacturer or by the service given on buildings in his locality. General directions given for putting on slate shingles should be followed. Special starting shingles are required.

There are three chief types of asbestos shingles according to shape and method of application—the side, or Dutch, lap (fig. 4, *A*); the rectangular, or American (fig. 4, *B*); and the hexagonal, or French (fig. 4, *C*). The thickness of these shingles is generally 5/32 inch, and the weight per square ranges from 260 to 280 pounds.

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[6] A square of roofing material is the quantity necessary to cover 100 square feet of roof surface.

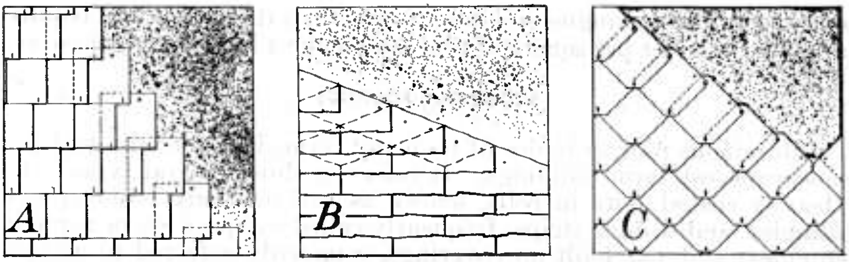

Figure 4.—**Types of asbestos shingles: *A*, Dutch, or side, lap; *B*, American, or rectangular; *C*, French, or hexagonal.**

The side-lap shingle (or Dutch lap) is approximately 16 by 16 inches and weighs about 280 to 290 pounds per square. The method of laying is shown in figure 5. This shingle is laid with one-fourth or one-third side-lap. The one-third lap is preferred because the shingles look better when a smaller section is exposed and they make a tighter roof, but the one-fourth lap gives somewhat lighter weight and lower cost.

More detailed instructions for laying asbestos shingles according to the various methods may be obtained from manufacturers and dealers.

The American shingle usually comes in strips 24 to 30 inches long and 12 to 15 inches high and is applied like slates. The strip shingles give the appearance of smaller individual shingles. They weigh about 280 pounds per square.

The hexagonal shingle is approximately 16 by 16 inches, weighs about 260 pounds per square, and is held in place by nails and storm

Figure 5.—**Roof covered with side-lap asbestos-cement shingles. The metal strips holding the scaffold should be clipped off even with the edge of the shingle when the roofing has been completed. Snow guards protrude between the shingles near the bottom.**

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anchors. These shingles so laid cost less than the Dutch lap, require a smaller number per square of roof, and make a lighter-weight covering.

BITUMINOUS ROOFINGS

Bituminous roofing in one of its many forms is commonly used for moderate-cost farm buildings. It comes in three general types: (1) Heavily coated felts in rolls, known as roll or ready roofing; (2) shingles and shingle strips, frequently called composition or asphalt shingles; and (3) built-up coverings, commonly referred to as tar-and-gravel roofing.

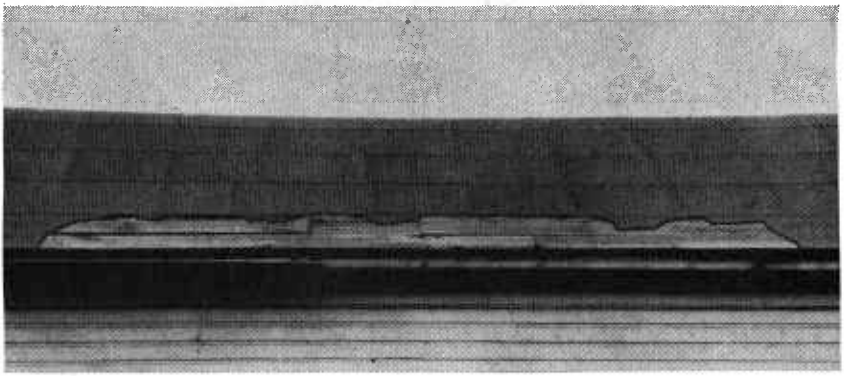
The base of these roofings is a felt, generally composed of such organic fibers as rag, wood, and jute, and is made on machines similiar to those used for paper making. Most prepared roofings—rolls and shingles—are composed of asphalt-saturated felt coated with bitumen and surfaced on the weather side with mineral granules, usually sand or crushed slate, brick, or tile. The under side is dusted with talc or mica to prevent the layers from sticking together. Roll roofing is also available without granular surfacing. The weight of prepared roofings is fairly well standardized by the industry and varies according to class and grade, the heavier grades giving longer service. Variations in color are dependent chiefly on the color of the embedded granules.

Coal-tar-impregnated felt is not employed for ready roofing or shingles. It is sometimes used in connection with built-up roofing, for covering temporary structures, and occasionally as sheathing paper.

Impregnated asbestos felts and metal-coated waterproof sheathing papers also are available but are not commonly used on farm structures.

A material often confused with impregnated felts is rosin-sized sheathing paper. This is merely a heavy building paper, generally red in color. It is used under tin roofing, because unneutralized acids of tar or asphalt felts corrode the metal, and also under tar-and-gravel built-up roofing over wood sheathing to prevent tar, which might run in summer, from trickling through the sheathing cracks. Lightweight tar-asphalt felts are generally laid under asbestos, composition, and slate shingles instead of the rosin-sized paper. Standard specifications for roll roofing and composition shingles are of little value to

Figure 6.—Lightweight felt roofing torn by the wind blowing through the wide joints between the sheathing boords.



the purchaser not equipped to conduct the required tests, and it is advisable to select a standard brand that has proved durable in the locality where it is to be used. In general, the heavier materials prove more satisfactory. Composition roofing on north slopes is less exposed to the sun and usually lasts longer than that on south slopes.

Lightweight Felt Roofing

Frequently, lightweight felts are used to cover sheds and chicken houses. This type of roofing, however, is suitable only as a very temporary covering because it is easily torn by the wind (fig. 6), especially if the wind can blow up through cracks in the sheathing.

Roll Roofing

Roll roofing, when of good quality and properly laid over tight sheathing, forms a low first-cost covering suitable for smaller farm buildings (fig. 7). The heavier grades might be used for reroofing over old asphalt shingles, provided the shingle surface can be made fairly smooth. While combustible after a fire has gained headway, roll roofing is not readily ignited by hot brands, especially if the slope of the roof is sufficient to prevent the lodgment of glowing embers.

The most common method of laying is to stretch the sheets parallel to the eaves (fig. 8), starting at the lower end and taking care to avoid wrinkles and bags. The next layer is usually lapped 2 or 3 inches over the edge of the lower sheet, and the ends of adjoining strips 4 to 6 inches. The laps are cemented together and then fastened to the wood sheathing with large-headed galvanized nails spaced about 2 to 3 inches apart, care being taken to avoid driving nails into cracks between the boards. If this happens they should be pulled out and the nail hole patched. Tin caps are not recommended for top nailing because they corrode quickly and leave the nailhead protruding so

Figure 7.—Poultry house covered with roll roofing. This is the usual method of nailing the edges over the eaves and gables. The location of the building is unfortunate as swaying branches wear the roofing.

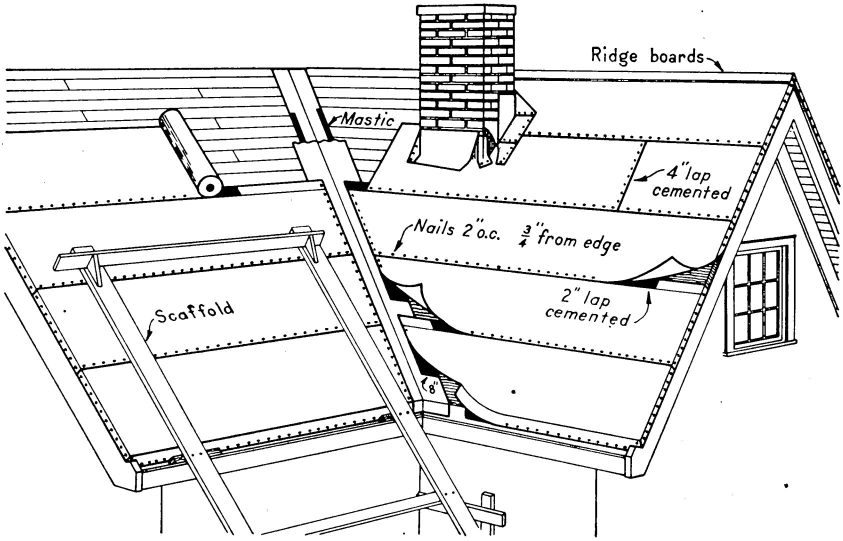
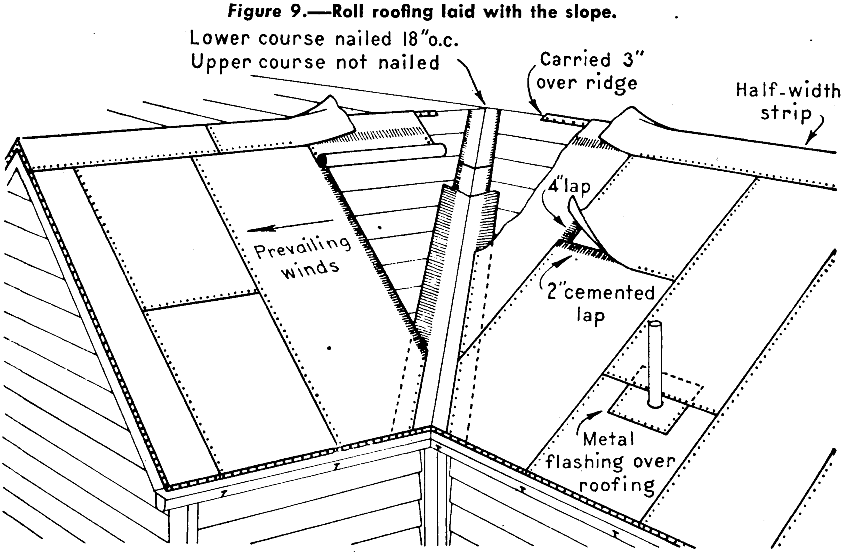


Figure 8.—Roll roofing laid parallel to the eaves; scaffolds should be provided as a safety measure for workmen.

that the roofing is easily torn off by the wind. Generally, enough cement and nails for one roll are included in the package with the roofing. The "blind nailing" method is not so commonly used but is recommended for applying smooth-surfaced roofing. Side laps should be 4 inches and end laps 6 inches, with the underlying edges nailed through tin or fiber disks on 6-inch centers. The overlying laps should be cemented with hot asphalt or special blind-nailing cement and the edges stepped down firmly to make them stick.

Roll roofing when laid with the slope of the roof (fig. 9) can be more easily stretched smooth before being nailed in place. Wood battens or patented metal strips, if used over the long laps, afford

Figure 9.—Roll roofing laid with the slope.



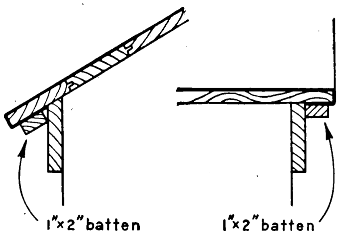


Figure 10.—**Battens for holding the edges of roll roofing at eaves.**

better protection to the roofing against tearing by the wind.

Necessary flashings are generally of the same material as the roofing, although copper foil cemented on the top ply of composition and built-up roofings is sometimes used. They are composed of two thicknesses of material (figs. 8 and 9), made tight by cementing all laps and edges with plastic cement or mastic. Flashings at chimneys are wedged and calked into the mortar joints. It is best to use rust-resistant metal chimney flashings on all but the cheapest work (pp. 24 and 26).

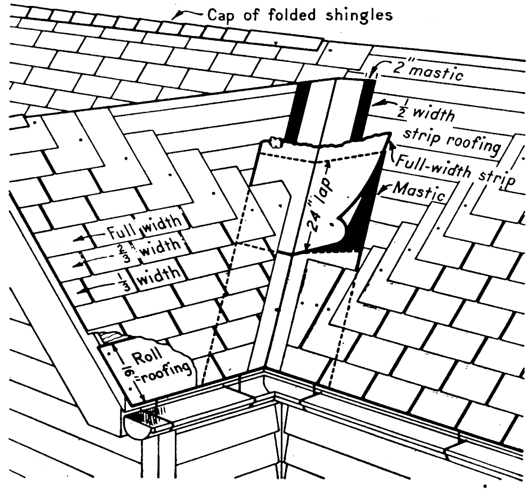
A method of fastening roll roofing at the eaves and gables better than the usual practice of nailing into the edge of the sheathing (fig. 7) is shown in figure 10. Barbed or cement-coated nails are best for nailing the battens.

A variation of the regular roll roofing that has proved useful is available. It is coated with mineral granules for only 1 inch less than half its width, the remaining width being uncoated. (The uncoated part is referred to as a 17- or 19-inch selvage.) The advantage of this material is that it can be laid in two thicknesses cemented together, the mineral coating exposed to the weather.

Asphalt Shingles

Asphalt or composition shingles have become an important and widely used covering because of their moderate cost, light weight, and relative durability. They are available as single shingles or in strips of several units. A large variety of shapes or patterns and colors is available. The strips can be laid with less labor than individual shingles. A common type is a three-shingle strip, 36 inches long by 12 inches wide, having cut-outs 5 inches deep and three-eighths of an inch wide that produce the same appearance on the roof as when individual shingles are used. Ordinary 12-inch shingles are laid with 5-inch exposure and have the same characteristics as heavy roll roofing. Lightweight composition shingles or heavier shingles with too large exposure are likely to curl badly on the roof after weathering. To reduce curling when a large exposure is desired, as in reroofing without removing the old covering, a number of types of "lock-down" composition shingles are made. General

Figure 11.—Laying asphalt shingles at a valley.



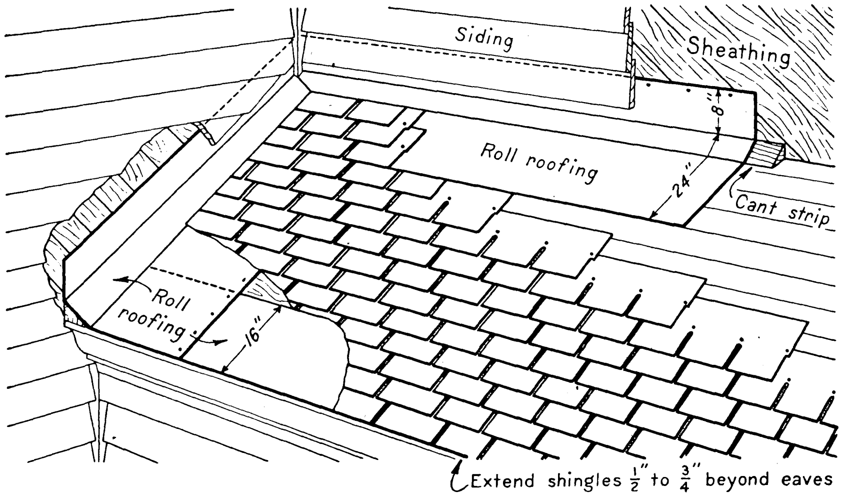


Figure 12.—**Laying asphalt shingles at side walls.**

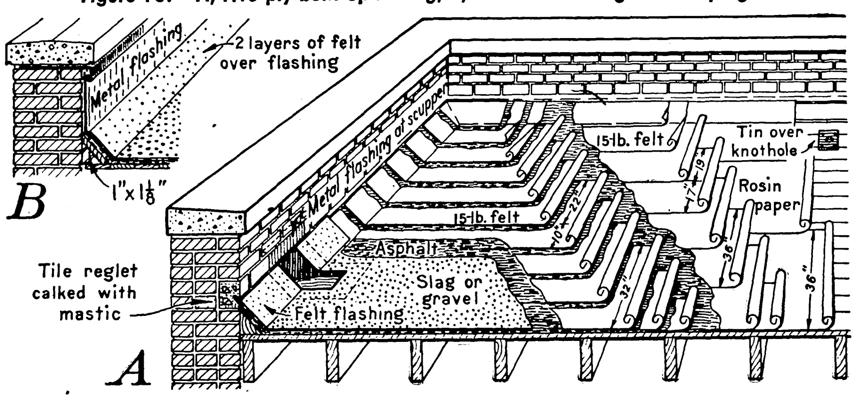
methods of applying different types are illustrated in figures 11 and 12 and in directions furnished by the manufacturers.

Built-up Roofing

Built-up roofing consists of several layers of lightweight impregnated felt, lapped and cemented together with a bituminous material and covered with a layer of small-sized gravel or slag, 300 to 400 pounds per square. Tar pitch must be used as the cementing material with tarred felt, and asphalt with asphalt felt. Asphalt built-up roofs should have enough pitch for water to drain readily but need not have gravel or slag surfacing. Coal-tar pitch built-up roofs must be surfaced and should be used on slopes of less than half an inch per foot or where water may collect and stand. Roofs are classed as 3-, 4-, or 5-ply, according to the number of layers of felt. The method of laying a 5-ply roof is illustrated in figure 13, *A*. The 3-ply roofing costs less than the 5-ply but will not last so long. Built-up roofing with gravel surfacing weighs 500 to 600 pounds per square.

Tar is more affected by heat and for this reason cannot be used on as steep a slope as can asphalt.

Figure 13.—**A, Five-ply built-up roofing; B, detail of flashing under coping.**



Built-up bituminous covering is suitable on roofs sloping ½ to 3 inches per foot. On greater slopes the roofing may slip in hot weather and the gravel is difficult to keep in place. On lesser slopes drainage is difficult owing to unevenness of the roof surface. The gravel covering is used to protect the tar or asphalt from disintegration by the elements and to afford fire resistance. A metal gravel stop (fig. 14) should be used at the eaves to prevent gravel from being washed away.

Parts of sheathing boards containing loose knots or other flaws should be discarded, or the knotholes and large cracks covered with sheet metal nailed in place. Care should be taken to see that the roofing is not installed over ragged or sharp corners. This can be avoided by the use of cantboards (fig. 13, *B*) at the intersection of the roof with vertical surfaces. The roof should be carefully flashed at junctions with walls, particularly in regions of heavy snows. Cap flashing for low parapet walls may be laid under the coping (fig. 13, *B*) and in brick walls, built into the brickwork or calked into a special tile. When pouring concrete walls, provision should be made for a reglet, or groove, for holding the cap flashing.

This type of roofing should be considered more often on account of its high fire resistance, long life, and reasonable cost. When laid in accordance with the manufacturer's specifications and by skilled workmen, the 5-ply roof is generally guaranteed to give 20 years' service. Manufacturers, upon request, supply illustrated instructions for laying built-up roofing of 3, 4, or 5 plies over wood or concrete surfaces.

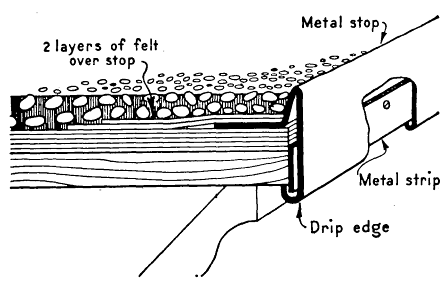


Figure 14.—Gravel stop of 26-gage galvanized metal on edge of sheathing. Stop is 1¾ to 2½ inches high on face.

Commercial Packages

The size and weight of commercial packages of bituminous roofing materials are given in tables 1 and 2. Different manufacturers' products vary somewhat in weight, depending on the thickness, size, and pattern of the product and the kind and quantity of coating.

TABLE 1.—*Average sizes and weights of bituminous roll roofings*

Material	Width	Area per roll	Weight per roll
	Inches	*Square feet*	*Pounds*
15-pound asphalt or tarred felt	32 and 36	432	60
30-pound asphalt or tarred felt	32 and 36	216	60
Slater's felt	36	500	32
Sheathing felt	36	500	35
Red rosin-sized sheathing paper	36	500	20, 25, 30, and 40
Roll roofing:			
Talc both sides	36	108	45 to 65
Mineral surfaced	36	108	55 to 90

TABLE 2.—*Average sizes and weights of bituminous shingles*

Kind of shingle	Size	Shingles per square	Weight per square	Kind of shingle	Size	Shingles per square	Weight per square
	Inches	*Number*	*Pounds*		*Inches*	*Number*	*Pounds*
Single:				Strips:			
Hexagonal	16 by 16	82	140	4-strip	12½ by 36	100	270
Side lap	12 by 16	113	160	Do	10 by 36	100	210
				3-strip	12 by 36	80	210

METAL ROOFINGS

Metal roof coverings are light in weight and those with locked or soldered joints can be used on flat slopes with little danger of leakage. They are fire-resistant and when grounded to the nearest lightning conductor usually require little further precaution to make them reasonably safe from damage by lightning. If not grounded, metal roofs do not protect from lightning and may increase the risk.

Metal roofs give little protection against heat or cold; therefore on dwellings they should be laid over tight sheathing or on one of the many forms of insulating material.

Sheet-copper and zinc roofs are durable but are little used on farm buildings because of the high cost. They are laid like tin roofing.

Tin

A tin roof of good material should last 40 to 50 years if properly laid and kept well painted. This type of roofing is not readily applied except by men experienced in the use of the special tools needed. The important features and general methods of application are given to point out the essentials required for a good tin roof.

The so-called tin roofing is really a soft steel, or sometimes a wrought iron, coated with a mixture of lead and tin. This material is more properly known as terneplate.

At one time black sheet-metal plates or sheets were dipped into a bath of the hot metal, which permitted heavy coats, but now the plates are run through rollers after they have been dipped, to regulate the thickness of the coating.

The plates are made in different sizes, usually 10 by 14, 14 by 20, and 20 by 28 inches, and are obtainable in two thicknesses, IC and IX, the IX being the heavier. The thickness of the metal does not add appreciably to the life of the plates, as their durability is dependent on the thickness of the coating. The plates are sold in boxes of 112 sheets unless the weight exceeds about 300 pounds, in which case they are packed in multiple units of 14 sheets. Terneplates can be had with 8, 15, 20, 25, 30, or 40 pounds of coating per box, the 30-pound coating being very popular. The IC thickness is best for the main roofing, as it is easier to work and is less likely to cause expansion trouble than the IX plates, which are generally used for flashings, valleys, and such.

The plates should be laid over tight sheathing, preferably tongue-and-groove lumber, well seasoned and of uniform thickness. The use of rosin-sized or other kinds of sheathing paper free of tar is recommended to deaden the noise of rain and wind on the roof. It is not advisable to lay a tin roof over old tin, rotten shingles, or tar roofs. The under side of the metal should be painted with metallic brown or

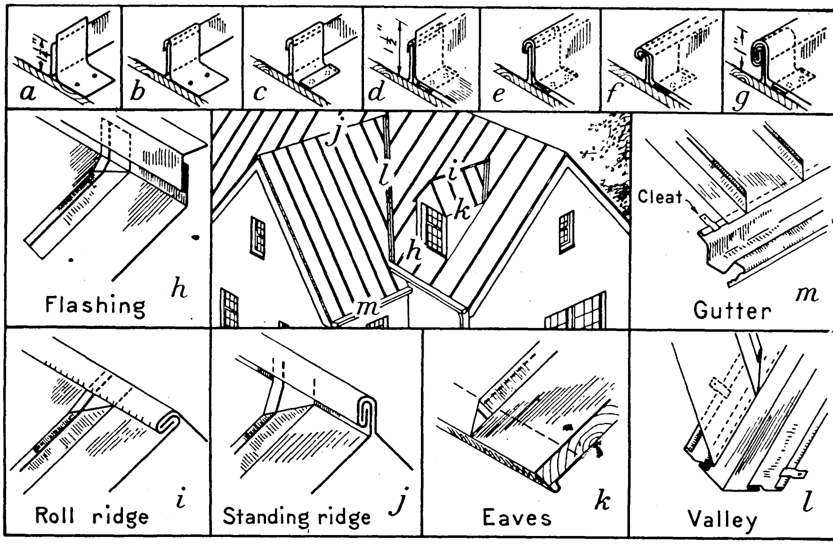


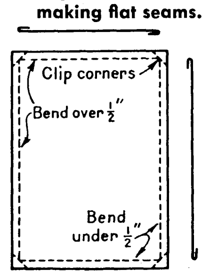
Figure 15.—**Details of installing standing-seam roofs: *a* to *g*, steps in the process of forming a standing seam; *h* to *m*, joints at breaks in the roof.**

red lead; this is generally applied in the shop. Only rosin should be used as a flux in soldering.

When a roof slopes more than 3 inches per foot the metal should be laid with standing seams parallel to the direction of slope. The 20- by 28-inch sheets are generally used and by soldering may be made in the shop into long strips, rolled for convenient handling. In applying the metal, one edge of the strip is turned up at right angles 1¼ inches, then cleats of the same material, spaced 8 to 12 inches apart, are installed by nailing one end to the sheathing and folding the other end over the upstanding edge of the strip (fig. 15, *a*). The adjoining edge of the next strip should be turned up 1½ inches and the abutting upstanding edges locked, turned over, and flattened tightly against one side of the standing seam. Unlike the flat seams used in making up the rolls, these seams are not soldered. Standing seams should be straight, rounded neatly at the top edge, and stand 1 inch above the roof surface. The general method of laying standing-seam tin roofs is shown in figure 15. Light-gage plain galvanized steel is sometimes laid in the same manner.

When a roof slopes less than 3 inches per foot, heavily coated plates should be used, laid with flat seams, with sheets 14 by 20 inches to provide sufficient stiffness against buckling. The metal should be so laid that the short dimension will be parallel with the eaves and all seams will be flattened on the roof. The seams should be made by turning the edges of each sheet half an inch, as shown in figure 16, and locking and soldering them together. If the sheets are laid one at a time they should be secured to the roof with three cleats (fig. 15, *a*), two on the long side and one on the short. When the sheets are made into long lengths at the shop, the short edges are locked and soldered together. The edges of the long lengths should be turned back half an inch to permit the interlocking of adjacent strips

Figure 16.—Folding edges of sheets for making flat seams.



and secured in place with cleats. The interlocked seams of adjacent strips should be flattened and soldered watertight.

Terneplates are now available in rolls of 50 or 100 feet and in widths of 14, 20, 24, or 28 inches. The coatings are 8, 20, or 40 pounds per 436 square feet. The IC weighs 62 pounds per square and the IX, 76.

Galvanized Steel

Galvanized-steel roofing has been used on farms for many years. Where good materials have been applied and properly cared for, this roofing has been economical and satisfactory. Poor or light materials when neglected have failed in a few years from rusting. Alloy steels are more resistant to rust than the common plain steel, but durability depends chiefly on the protective zinc coating. For reasonable use, lightly galvanized sheets must be kept well painted. Galvanized roofing with a guaranteed minimum coating of 2 ounces of zinc per square foot has been on the market for some years under a special "seal of quality." The heavy coating insures long life under ordinary conditions, but eventually painting will be needed for maximum service. When, after prolonged exposure, painting is indicated, the proper application of a good rust-preventive paint will extend the life of the roofing considerably. Galvanized steel roofings for farm buildings should be No. 28 gage or heavier. The lower the gage number, the heavier the sheet.

When new, galvanized metal is difficult to paint. An effective method is to remove oil and grease by washing with turpentine or mineral spirits and after drying the surface to apply a priming coat of zinc dust-zinc oxide primer paint. A finish coat of paint may then be readily applied. If painting is unnecessary when the roof is laid it is advisable to delay its application for a year, when the surface usually will be in good condition to receive it without a primer. Graphite and tar paints should be avoided on all metal coverings.

V-Crimp Steel

V-crimp steel roofing is reasonable in cost, can be readily applied without special skill or tools, and looks very much like a standing-seam tin roof. It is manufactured in sheets about 26 inches wide (designed to cover a width of 24 inches allowing for side lap) and in even foot lengths of 5 to 12 feet. It is available with 2-, 3-, and 5-V crimps. The 2- and 3-crimp cannot be made so watertight as the 5-crimp, which provides for a double lap. The sheets should be laid on fairly tight sheathing and if desired over rosin-sized sheathing paper. The ends of adjoining sheets should lap 6 inches. The edges of the 2- and 3-crimp sheets should lap over 1 crimp, and those of 5-crimp sheets, 2 crimps. It is advisable where durability is a factor to use only the heavier weight heavily galvanized metal.

Corrugated Sheets

Corrugated galvanized-steel roofing is used extensively on farm buildings. The corrugations add stiffness to the sheets and permit omission of sheathing, which lowers the cost of the roof but provides no insulation against cold or heat. This type of roofing is available with 1¼-inch corrugations in sheets 26 inches wide and with 2½-inch corrugations in sheets 27½ inches wide. Sheets are made in even foot lengths of 5 to 12 feet. The width of a sheet will cover 24 inches.

When no sheathing is used the steel sheets are laid on rafters with 2- by 4-inch headers cut between them (fig. 17). Sometimes rafters

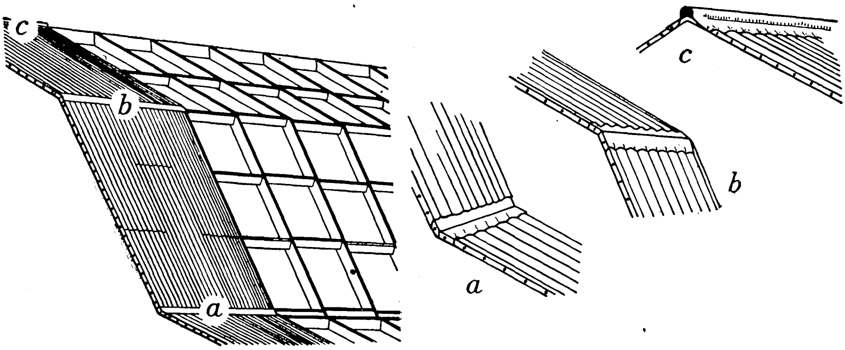


Figure 17.—**Corrugated metal roof without sheathing: *a*, Eaves joint; *b*, hip; *c*, ridge cap. Headers are staggered to permit nailing through rafters.**

spaced 2 feet on centers are covered with 1- by 4- or 1- by 6-inch roofing slats spaced 2 feet apart. These should be of sound, dense wood to give the nails proper anchorage against wind. When close sheathing is used it may be covered with rosin-sized sheathing paper.

The sheets should be lapped at the ends as follows: 4 inches for more than a 6-inch rise per foot; 6 inches for a 6-inch rise; and 8 inches for a 4-inch rise. Side laps should be 1½ corrugations. The sheets should be fastened with nails 8 inches apart driven in the tops of corrugations at all laps and intermediate supports. Lead washers under the nailheads, or special nails with lead-protected heads, must be used. Screw-type nails have great holding power. All laps should be made over supports. Flashings at hips, valleys, eaves, chimneys, and such should be of galvanized metal supported throughout their length. Open valleys should be used and lined with galvanized metal one or two gages heavier than the main roof. Special valley sheets are made for galvanized roofing.

Special ridge rolls, joints, and flashings for use at hips, eaves, and chimneys are made to put on with this type of roofing and aid in building a tight roof. The V-crimp sheets make a better appearance than corrugated metal and can be used when close sheathing is provided. More detailed instructions for laying steel roofing can be obtained from manufacturers.

Corrugated and V-crimp aluminum sheets are now available at about the same price as galvanized steel. High resistance to corrosion without painting and heat-reflecting value should make this a desirable roofing material for farm buildings. Aluminum fastenings and flashing should be used.

Corrugated roofings of sheet zinc, cement-asbestos, and asbestos-coated metal are used on some industrial buildings that are subject to specially deteriorating conditions but are more costly than steel.

CANVAS ROOFING

Canvas roofing has been used for years where a flat roof must be walked upon. It is light in weight, not readily broken under light traffic, long-lived and watertight when kept well painted, and not difficult to lay. It is frequently used along the seacoast and for covering boat decks and railroad cars.

This type of roofing is relatively high in cost but is not expensive considering its durability under the severe service generally imposed upon it.

Canvas, called by manufacturers cotton duck, is made in two general classes—the numbered duck and the ounce duck—the distinction depending upon the method of weaving. Numbered duck is indicated by numbers and ounce duck by ounces. The highest number, 12, is the lightest, weighing 7 ounces per linear yard 22 inches wide, while the lowest number, 00, weighs 20 ounces. The weights of consecutive numbers increase by 1 ounce from No. 12 to No. 00. Ounce ducks weigh from 6 to 15 ounces per linear yard 28½ inches wide and are made in three grades—army, double filled, and single filled. The last two are not suitable for roofing but are generally used for awnings.

For roofing, the canvas should be unbleached, unsized, closely woven, and not lighter than the 10-ounce grade, although No. 6 and No. 2 are recommended when the roof is to be walked on a great deal. Canvas is available in different widths up to 120 inches, but the 22- and 28½-inch widths of numbered and ounce duck, respectively, are most commonly used for roofing.

The surface upon which the canvas is to be laid must be smooth and tight. It is advisable to use tongue-and-groove flooring 2½ to 4 inches wide. Sheathing 6 to 8 inches wide could be used but is not so good because of greater shrinkage. If the boards cup or warp, the raised edges will make ridges that will wear through the canvas.

In laying a canvas roof the wood sheathing should first be painted with a paint made on the following basis, if a light-colored roof is desired: 100 pounds of white lead in oil heavy paste, 4 gallons of raw linseed oil, 2 gallons of turpentine, and 1 pint of liquid drier. When this paint is thoroughly dry, a heavy coat of the white lead heavy paste should be applied.

The canvas should be placed on the surface and firmly pressed down into the wet paste. A smoother surface is obtained if the canvas is pressed down with rollers. Stretch it slightly and fasten it along the edges with ¾-inch copper tacks or galvanized nails spaced 4 inches apart. The top face should be painted at the edges with heavy paste and the adjacent strip of canvas lapped 1½ inches. The finished joints should be nailed with ¾-inch copper tacks spaced ¾-inch apart. Flashings of canvas are installed in the same manner as flashings of other material.

After the canvas has been laid the exposed surface should receive three coats of paint. The priming coat should be mixed on the following basis: 100 pounds of white lead in oil heavy paste, 3 gallons of raw linseed oil, 2 gallons of turpentine, 1 pint of liquid drier. The second and the finishing coats may be any good paint designed for outside use. The drier may be omitted from the bedding and priming coats if ample time is available for drying—about a week—between coats.

Another method often used in placing the canvas is to stretch it tightly and nail it in place, omitting the paint on both the under side and the sheathing. The canvas is then soaked with water. As soon as the surplus water has disappeared, but while the canvas is still wet, it is painted. The same paints may be used as recommended for the first method of laying, and the priming coat should be worked well into the canvas.

Good results have been obtained by painting the sheathing, wetting the canvas and stretching it on the wet paint, and working in the priming coat when the canvas has partly dried out.

If kept well painted, a canvas roof should last 25 or 30 years.

REPAIRING ROOFS

LOCATING LEAKS

Periodic inspections should be made to detect breaks, missing shingles, choked gutters, damaged flashings, and also defective mortar joints of chimneys, parapets, coping, and such. At the first appearance of damp spots on ceilings or walls, a careful examination of the roof should be made to determine the cause, and the defect should be promptly repaired. When repairs are delayed, small defects extend rapidly and involve not only the roof covering but also the sheathing, framing, and interior finish.

Many of these defects can be readily repaired by a practical man so as to keep water from the interior and to extend the life of the roof. Large defects or failures should be repaired by men familiar with the work because on many types of roofs an inexperienced man can do more damage than he is likely to repair.

Leaks are sometimes difficult to find, but an examination of the wet spots on a ceiling furnishes a clue to the probable location. If near a chimney or exterior wall the leak is probably caused by defective or narrow flashing, loose mortar joints, or dislodged coping. On flat roofs the trouble may be the result of choked downspouts or an accumulation of water or snow on the roof higher than the flashing. On sloping roofs at valleys and at the junction of dormers with the roof, corroded, loose, or displaced flashing and rotten shingles may be found. Defective and loose flashing is not uncommon around scuttles, cupolas, and plumbing vent pipes. Roofing deteriorates more rapidly on a south than on a north exposure, which is especially noticeable when wood or composition shingles are used. The south slope of a roof should be watched closely for leaks.

Wet spots under plain roof areas are generally caused by holes in the covering. Frequently the drip may occur much lower down the slope than the hole. Where attics are unsealed and roofing strips have been used holes can be detected from the inside by light shining through. If a straw is stuck through the hole it can be located from the outside. Sometimes gutters are so arranged that when choked they overflow into the house, or ice accumulating on the eaves will form a ridge that backs up melting snow under shingles. Leaky downspouts permit water to splash against the wall and the wind-driven water may find its way through a defect into the interior.

REPAIRING SMALL DEFECTS

The exact method to use in repairing depends on the kind of roofing and the nature and extent of the defect. The methods of installing flashings are given on pages 26 and 27.

Missing shingles may be replaced with similar shingles or pieces of rust-resistant metal; in cases of emergency a temporary repair can be made with metal cut from a tin can. The metal should be painted on both sides and slipped under the shingles in the upper layer, care being taken not to dislodge or loosen sound shingles. Old nails can be cut out with a long, thin cold chisel. After the repair has been made, exposed nails should be covered with roofer's cement.

Small holes in metal roofing should be closed with a drop of solder and larger ones with a patch of the same kind of roofing, soldered over

the hole. When soldering tools are not at hand small holes can be readily sealed with a plug of elastic roofer's cement and large ones by pasting a piece of canvas (or several thicknesses of cloth from a cement sack) over the hole, applying thick paint for the adhesive and several coats of paint on top. This method is also effective for large holes in corroded gutters and downspouts.

When metal roofing is riddled with small pinholes and it is not feasible to reroof for several years, an application of a heavy-brushing bituminous coating may be effective. These materials are readily available at builders' supply houses and are sometimes used on roll roofing and composition shingles when the surfaces have been worn fuzzy by the elements. Asphalt coatings should not be used on tarred felt nor should coatings having a tar base be used on asphalt felt. The type of coating may be identified by the brand name, if known, or by dealers.

Holes in built-up roofing are difficult to locate but are readily repaired. Leaks generally occur in sinks or low places in the roof and usually the area in their locality remains damp longer than do sound areas. The loose gravel or slag should be swept aside for later use and the various layers of worn-out felt and tar coatings cut out.

Care must be taken not to rip the covering so as to involve too large an area. The layers should be cut out in steps so the bottom layer has the smallest area and the succeeding layers will lap over the next lower by 1 to 2 feet, preventing a hump when the patch is completed.

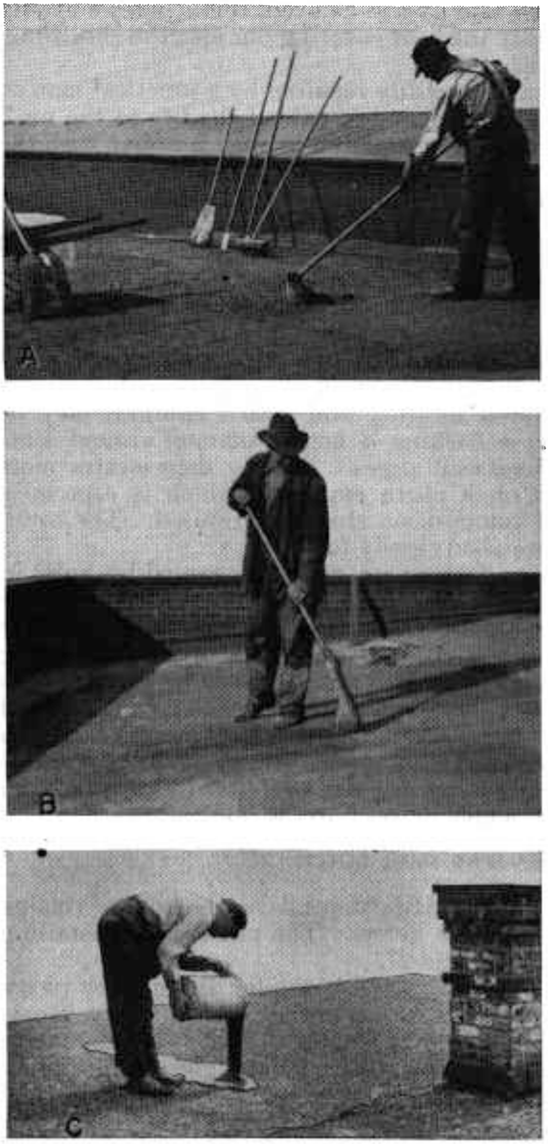


Figure 18.—**Resurfacing a built-up roof: *A*, Sweeping off loose gravel; *B*, sweeping off dust and sand; *C*, pouring on a cold-application repair material.**

Finish with at least one additional layer of felt extending 6 inches or more beyond the other layers. The patches are embedded in hot tar or asphalt, and a generous application of the tar should be poured over the last layer for embedding the gravel. Repair material that is applied cold is also available. Follow manufacturers' directions in its use. The life of a built-up roof can be extended considerably if, after years of service, the loose gravel is scraped off, the roof recoated with tar or asphalt, and the gravel replaced before the coating has hardened (fig. 18). In built-up roofs if repairs are needed in many places it is frequently advisable to put on a new roof.

When repairing any type of roofing, loose flashing should be securely fastened in place and joints filled with roofer's cement, or, if the joint in which the flashing is anchored is wide, oakum rolled in roofer's cement and calked in the joint will prove economical and effective. The metal of open valleys, if badly corroded, should be replaced with new metal. Closed valleys are more difficult to repair, and if it is not feasible to slip pieces of metal up under the shingles where leaks occur, the services of a roofer should be obtained. Square pieces of metal folded on the diagonal should be used so the wedge-shaped point may be slid past nails.

Loose mortar of chimneys should be raked out and the joints repointed with a mixture of 1 part portland cement, 1 part lime, and 6 parts sand.

As a safety measure for the person repairing a roof, scaffolds, ladders, or a rope should be provided. Several types of scaffolds are shown in the illustrations of this bulletin. Soft-soled shoes should be worn when working on a roof to avoid breaking the roofing material.

CONSIDERATIONS IN SELECTING ROOFING

Each type of roof covering has characteristics affecting its selection for use under certain conditions, some of which are listed in table 3.

Roofings are commonly sold by dealers or manufacturers on the basis of quantities sufficient to cover 100 square feet of roof area. Additional allowances must be made for waste, hips, valleys, and starter courses. This applies in general to all types of roofing.

The slope of the roof and the strength of the framing are the first determining factors in choosing a suitable covering. If the slope is slight there will be danger of leaks with a wrong kind of covering, and excessive weight may cause a sagging that is unsightly and adds to the difficulty of keeping the roof in repair.

The cost of roofing depends to a great extent on the type of roof to be covered. A roof having many ridges, valleys, dormers, or chimneys will cost considerably more to cover than one having a plain surface. Very steep roofs are also more expensive than those with a flatter slope, but most roofing materials last longer on steep than on low-pitched roofs. Frequently nearness to supply centers permits the use, at lower cost, of the more durable materials instead of the commonly lower-priced, shorter-lived ones.

In considering cost, one should keep in mind maintenance and repair and the length of service expected from the building. A permanent structure warrants a good roof even though the first cost is somewhat high. When the cost of applying the covering is high in comparison with the cost of the material, or when access to the roof is hazardous, the use of long-lived material is warranted. Unless insulation is re-

TABLE 3.—*Recommended minimum roof slope and approximate weights and costs of various roof coverings*

Type of roofing	Minimum allowable slope per foot, with ordinary lap	Approximate weight per square	Approximate cost per square (materials only) [1]	Type of roofing	Minimum allowable slope per foot, with ordinary lap	Approximate weight per square	Approximate cost per square (materials only) [1]
	Inches	*Pounds*	*Dollars*		*Inches*	*Pounds*	*Dollars*
Aluminum	4	30	11	Roll roofing:			
Asbestos shingles:				2- to 4-inch lap	4	100	3
American pattern	4	280	12	17- to 19-inch lap	1	125	6
Dutch pattern	5	280	12	Slate	6	800	15
Hexagonal pattern	5	260	11	Tin:			
Asphalt shingles	4	200	6	Standing seam	3	75	11
Built-up roofing	½	600	8	Flat seam	½	75	11
Canvas, 8- to 12-ounce	½	25	20	Wood shingles	6	200	6 to 10
Galvanized steel:							
Corrugated	4	100	11				
V-crimp	2½	100	11				

[1] These costs are for plain roofs in the vicinity of Washington, D. C., summer of 1946. Local availability of a material may result in prices different from those shown. Cost is considerably increased by breaks in the roof.

quired, semipermanent buildings and sheds are generally covered with low-grade roofing.

Frequently the importance of fire resistance is not recognized, and sometimes it is wrongly stressed. It is essential to have a covering that will not readily ignite from glowing embers,[7] but unless proper precautions against inside fires have been provided, a noncombustible roof is unnecessary except where it is exposed to sparks, as from passing locomotives. The building regulations of many cities prohibit the use of certain types of roofings in congested areas where fires may spread rapidly. Farm buildings generally are isolated, and if the roof surfaces are kept smooth and in good repair most of the coverings commonly used in rural sections afford reasonable protection. The National Board of Fire Underwriters has grouped many of the different kinds and brands of roofing in classes according to the protection afforded against spread of fire.

The appearance of a building can be changed materially by using the various coverings in different ways. Wood shingles and slate have a beauty that lends itself to producing architectural effects. The roofs of buildings in a farm group should harmonize in color even though similarity in contour is not always feasible.

The action of the atmosphere in localities where the air is polluted with fumes from industrial works or is saturated with salt, as along the seacoast, shortens the life of roofings made from certain metals. Roofings having an iron base, even though galvanized, are particularly susceptible to such corrosion, and if used they should be kept well painted; copper and zinc are much more durable in these areas.

All coal-tar pitch roofs and also asphalt roofs in hot climates should be covered with slag or a mineral coating because where fully exposed to the sun these materials deteriorate rapidly. Observation has shown that, in general, roofings with light-colored surfaces absorb less heat and consequently last longer than those with dark surfaces.

Considerable attention should be given to the comfort derived from a properly insulated roof. A thin uninsulated roof gives the interior little protection from heat in summer and cold in winter. Discomfort from summer heat can be lessened to some extent by ventilating the space under the roof. Corrugated metal, when used on animal shelters, should be insulated to prevent moisture condensing on the under side. If it is necessary to reroof, consideration should be given to the insulating value of the covering and to the feasibility of installing extra insulation under the roofing. Manufacturers of insulation ordinarily furnish directions for using their products.

NEW ROOFS OVER OLD

If new roofing can be laid over the old, the work can be done without exposing the interior of the building to the weather, the old roofing will provide additional insulation, and the labor and mess incident to removal will be avoided. Before selecting new covering, however, the roof framing should be examined to determine whether it has sufficient strength to carry the additional weight. Slate, clay tile, and built-up roofing are heavy, and when they are used the rafters may require bracing. When the framing cannot be properly braced it may be necessary to remove the old covering to lessen the

[7] See Farmers' Bulletin 1590, Fire-Protective Construction on the Farm, pp. 8–9.

load. It is advisable, and in most cases necessary, to remove metal coverings, and if slate or other brittle roofings are selected the old covering should be taken off so as to provide a smooth deck, because any unevenness will cause breakage and waste.

There is a decided advantage in not removing old roll roofing and composition shingles, especially when reroofing with rigid shingles or metal, provided the old covering is not puffy or badly wrinkled and the framing will sustain the additional weight. Puffy areas should be slit or cut so that the old roofing may be nailed flat. When the new covering is metal, rosin-sized paper should be laid over the old surface. Old nails at the eaves may have to be removed and new strips of wood fastened under the edges of the sheathing to provide for secure nailing when turning down the edges of the roofing. If the new strip is not provided the additional nails may split the edges of the sheathing and permit the wind to blow under the new covering.

In preparing an old wood-shingle surface for a new covering, all curled, badly warped, and loose shingles should be nailed flat and secure, and all protruding nails should be driven down. The various steps are shown in figure 19. Old shingles along the edges of eaves and gables, for a distance of 2 to 4 inches, should be removed to permit the installation of a wooden strip or slat so as to conceal the old shingles at the edges of the roof and provide a firm nailing base. Open valleys should be filled in with wood strips level with the old shingle surface, on top of which a new valley sheet should be laid. A piece of bevel siding, thin edge down, should be nailed along each side of the ridges to provide a substantial nailing base.

The same procedure followed in laying shingles on a new solid-deck roof structure is used in overroofing, even though the original shingles were nailed on lath or strips. That is, no attention need be given the manner in which the nails penetrate the old roof beneath—whether they strike the strips or not—for with the longer nails (fivepenny, 1¾ inches long) that are used, complete penetration and anchorage is obtained.

ROOFING DETAILS

NAILS

Experience has proved the wisdom and economy of using rust-resistant nails. Even low-grade roofing will not give maximum service when lightweight steel nails are used. Only hot-dipped zinc nails, copper, heavily galvanized cut nails, or those of the special type recommended by the roofing manufacturer should be used. They should be long enough to penetrate about three-fourths the thickness of the sheathing.

FLASHING

It is necessary to flash ridges, valleys, and the junctions of the roof with the chimney or other vertical surfaces. Flashing should extend up vertical surfaces at least 6 inches and be counterflashed. Sheet metal is ordinarily employed, though roll roofing or felt is used with bituminous coverings and canvas with canvas roofing. The lasting quality of the flashing should be equal to that of the roofing. Soft copper, zinc, or hard lead, therefore, should be used with tile, slate, and asbestos shingles. Copper for flashing should weigh not less than 16 ounces per square foot, lead not less than 3 pounds per square foot, and zinc should not be lighter than No. 9, which weighs about 12 ounces

Figure 19.—Laying new shingles over old ones: *A,* Cutting away old shingles at gables to provide for nailing strip. Old shingles could be sawed off flush with the cornice and a suitable strip applied to the side, the top even with the old roof. *B,* Nailing strip at gable edge. *C,* Filling in an open valley. *D,* Placing new shingles with double course at eaves. *E,* New chimney flashing and temporary wood strip in valley for lining up shingles. *F,* Strips of bevel siding laid thin edge down to provide for solid nailing at ridge. Similar strips are sometimes used over each course of butts to provide a smooth surface for other types of roofing.

per square foot. Painted sheet iron or "tin" is frequently used for flashings with wood shingles, but it is advisable to use either the best quality of 26- or 24-gage galvanized metal or heavily coated IX flashing tin, painted on both sides with red lead, or one of the higher priced materials. Like metal roofs, exposed parts of the less durable metal flashings should be kept painted.

Several types of specially made flashing materials are also available, such as the lightweight sheets of copper or steel protected on both sides with baked-on asphalt or bonded asphalt-saturated fabric, or the double layer of bituminous felt reinforced with cotton or steel-wire mesh, which are claimed to be durable.

Copper is seldom painted except to prevent the staining of other surfaces. Paint applied to untreated copper will not last long so it is advisable to wash the surface with a solution of 4 ounces of copper sulfate in half a gallon of lukewarm water to which is added one-eighth ounce of nitric acid. (Glass vessels should be used for mixing.) Before painting, all traces of the acid should be removed with water and the surface allowed to dry. For aluminum roofs aluminum flashing should be used. Sheet zinc, lead, and aluminum are not ordinarily painted.

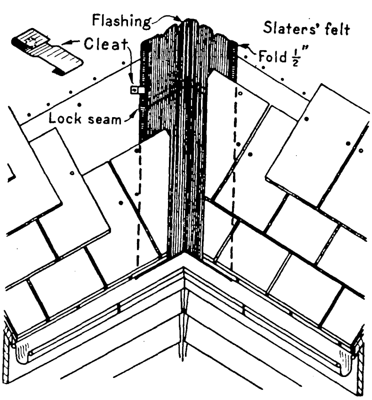
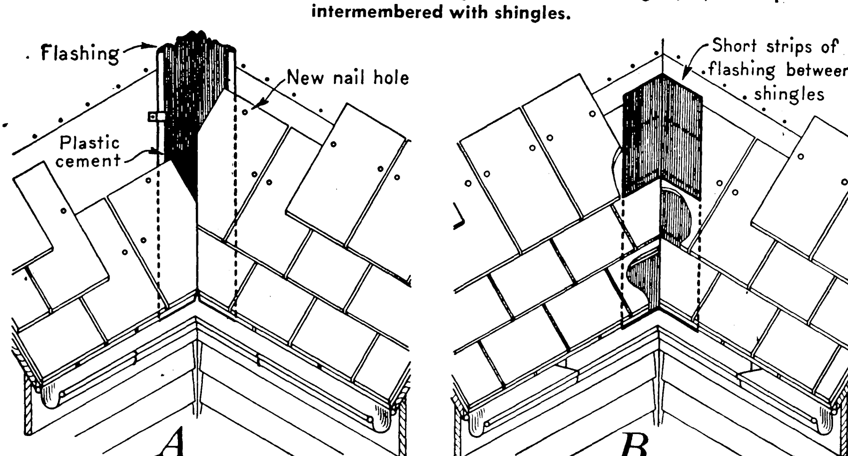


Figure 20.—Open valleys flashed with metal. The figure shows a slate roof.

Valley flashings are frequently made too narrow, with the result that the valleys fill up during heavy rains and permit water to penetrate under the roofings. Open valleys should be at least 4 inches wide at the top and should widen out at the rate of one-eighth inch per foot of length so as to increase their water-carrying capacity. On roofs sloping 45° or more the flashing strips should be 18 inches wide, and on flatter roofs at least 20 inches wide. When the adjacent roof surfaces are of different areas or slopes, a baffle rib will prevent the

Figure 21.—Closed valley flashings: *A*, Long sheets under shingles; *B*, short pieces intermembered with shingles.



larger or faster descending volume of water from forcing its way up under the roofing on the opposite side. The baffle may easily be formed as a V-crimp along the center line of the valley.

Cross seams should be locked and soldered to form one continuous strip for open valleys. Proper methods of fastening the metal to the sheathing with cleats is shown in figure 20. Closed valleys where slate or asbestos shingles are used may be flashed with a continuous metal strip under the shingles (fig. 21, *A*) or by building in short pieces of metal as the shingles are laid (fig. 21, *B*). Where nail holes of slate or asbestos shingles come over the metal, new holes should be provided in each slate so it can be secured by two nails located outside the metal. It is good practice to embed in plastic cement the edges of slate and other coverings that lap the flashing.

When flashing extends up vertical surfaces it must be counterflashed with cap flashing. The cap flashing should not be fastened rigidly to the base flashing. In masonry walls a groove half an inch high and about 1½ inches deep, into which the cap flashing is folded, wedged, and calked, is provided 6 inches or more above the roof level. In brick walls the cap flashing may be built into the joints, or a reglet tile may be used (fig. 13, *A*), and in concrete walls the groove may be formed at the time of pouring the concrete. The method of flashing at a chimney located on the ridge is shown in figure 22. A cricket, or saddle, should be provided behind a chimney[8] located on a slope, to divert water coming from the upper part of the roof and to prevent ice forming behind the chimney. Plumbing vent stacks should be flashed so as to permit the pipe to settle or expand without causing leaks.[9]

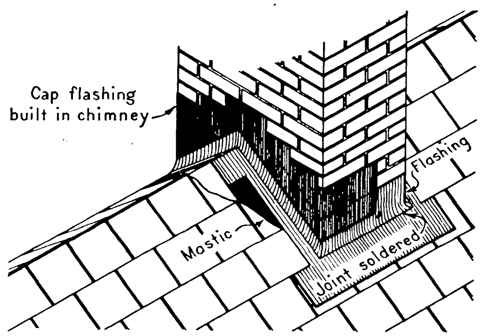


Figure 22.—**The cap flashing is built into the joints when the masonry is laid and is folded down at least 4 inches over the base flashing that is installed when the roofing is placed.**

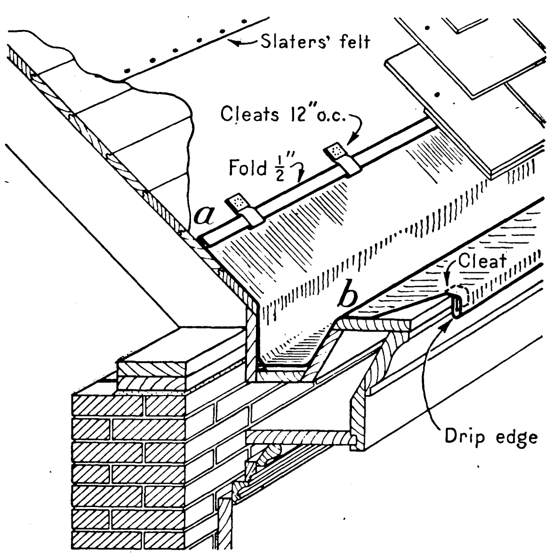


Figure 23.—**Built-in gutter. Flashing should be at least 2 inches higher at *a* than at *b*.**

[8] See Farmers' Bulletin 1889, Fireplaces and Chimneys, fig. 15.

[9] Farmers' Bulletin 1426, Farm Plumbing, shows methods of flashing vent stacks.

While gutters are not necessary it is advisable to have them to prevent the formation of water holes around the building. If a cistern is used, gutters are imperative. They may be of wood built in (fig. 23) as a part of the cornice and lined with metal, or they may be metal troughs hung along the eaves (fig. 24).

. In regions of heavy snowfall the outer edge of the gutter should be half an inch below the extended slope of the roof to prevent snow banking on the edge of the roof and causing leaks. The hanging gutter is better adapted to such construction.

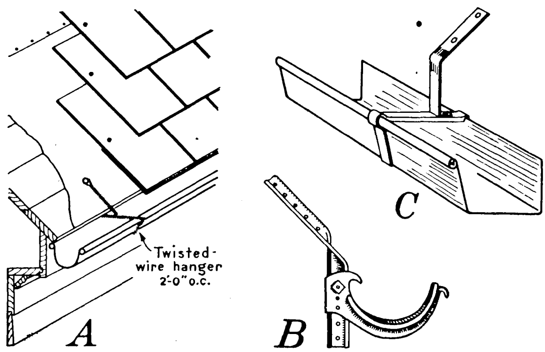


Figure 24.—**Hanging eaves trough: *A*, Circular section; *B*, adjustable hanger; *C*, rectangular section.**

The expense for maintenance can be considerably reduced if the gutters are built-in and are of first-class material, though the first cost is somewhat greater. Built-in gutters should be wide and shallow with the outer face sloped to prevent being broken by ice forming in the gutter and should be built entirely outside the wall line of the building. Gutters should slope about one-sixteenth inch per foot toward the outlet.

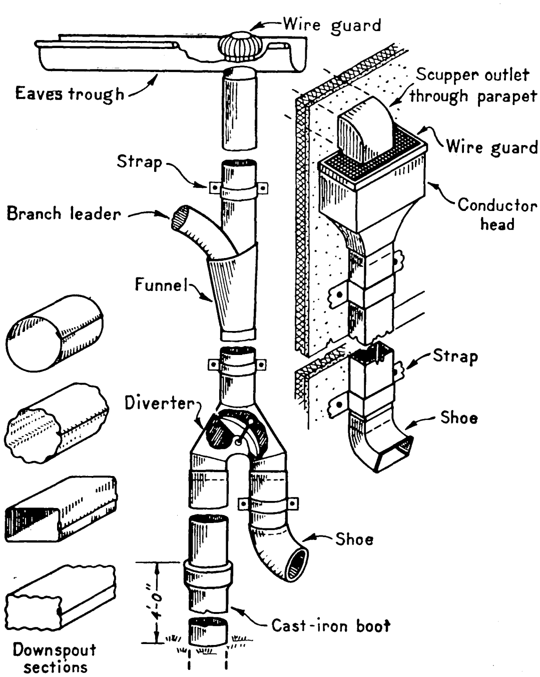


Figure 25.—**Downspouts and fittings.**

Downspouts (fig. 25) should be large enough to remove the water from the gutters. A common fault is to make the gutter outlet the same size as the downspout. At 18 inches below the gutter a downspout has nearly four times the water-carrying capacity of the inlet at the gutter; therefore an ample entrance to the downspout should be provided. Conductor heads or funnels are readily available from roofing establishments and should be used where branch downspouts converge or at scuppers of flat roofs. Wire baskets or guards should be placed at gutter outlets to prevent leaves and trash collecting in the downspouts.

TABLE 4.—*Sizes of eaves, troughs, and downspouts for various roof areas*

Roof area (square feet)	Eaves-trough diameter	Downspout diameter	Roof area (square feet)	Eaves-trough diameter	Downspout diameter
	Inches	*Inches*		*Inches*	*Inches*
100–800	4	3	1,000–1,400	5	4
800–1,000	5	3	1,400–2,000	6	4

In cold climates where water will freeze if it should stand in the downspouts, the use of corrugated instead of plain metal will save much trouble and probably prevent the pipe bursting because of expansion.

The lower end of each section of downspout should be fitted inside the next lower section, for if fitted over it water will flow out at the joint. Sometimes the joints are soldered tight, but for general practice this is not advisable, because normally slip joints eliminate the necessity of special provision to take care of expansion and contraction. Downspouts should be soldered to the straps that fasten them to the building. The lower end should be fitted with a shoe, or turn-out, when the water is to be wasted on well-drained ground, with a cast-iron pipe connection or boot when water is to be diverted into a storm sewer, or with a rain switch or diverter for excluding from a cistern the first part of each rain.

Intense rains occur periodically in certain localities but do no great harm to the contents or surroundings of farm structures if the gutters overflow for the duration of the storm. For the sake of economy, gutter and downspouts will be ample in size if large enough to carry off only normal storm water flow.

Sizes of downspouts and half-round gutters are suggested in table 4 for general farm use.[10] Local conditions, of course, may require larger sizes. Downspouts should be placed not more than 40 feet apart in the length of a gutter.

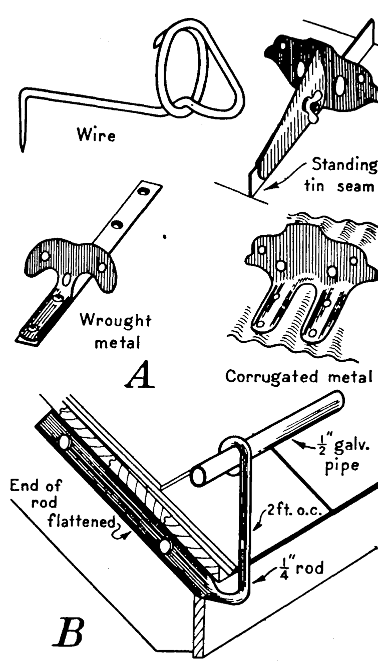


Figure 26.—**Snow guards: *A,* Common types installed at time of placing roof covering; *B,* home-made type.**

SNOW GUARDS

Snow guards should be used on steep roofs in cold climates to prevent

[10] See Farmers' Bulletin 1572, Making Cellars Dry, pp. 3–8, for a fuller discussion of downspouts.

sheets of ice or snow from sliding. Sliding ice will frequently tear off the roof covering, break gutters, or imperil the life of a person walking under the eaves. Several common types of guards that can be secured to the sheathing so as to project through the joints in the roofing are illustrated in figure 26, *A*. The guards should be staggered in three rows near the eaves and 6 to 12 inches apart, though they are often located only over entrances or at traveled places. A practical home-made type that can be installed without puncturing the roofing is shown in figure 26, *B*.

UNITS OF ROOF MEASUREMENT

Roof slope is usually indicated in one of two ways: (1) By the number of inches rise in 1 foot of horizontal distance and (2) by the pitch, or ratio, obtained by dividing the rise of a rafter by twice its horizontal run. The distance from the plate to the ridge measured along the rafters for a definite span depends on the slope of the roof. Information on estimating roof areas is given in table 5.

TABLE 5.—*Unit measurements for use in determining roof areas*

Inches rise per foot horizontal	Pitch [1]	Roof area per square foot of horizontal area	Inches rise per foot horizontal	Pitch [1]	Roof area per square foot of horizontal area
		Square feet			*Square feet*
0	0	1. 000	4	1/6	1. 034
1/2	1/48	1. 001	6	1/4	1. 118
3/4	1/32	1. 002	8	1/3	1. 202
1	1/24	1. 003	12	1/2	1. 414
1 1/2	1/16	1. 008	14	7/12	1. 537
2	1/12	1. 014	18	3/4	1. 803
3	1/8	1. 031	24	1	2. 235

[1] A rise of 24 inches per foot horizontal is termed full pitch.

The area in square feet of a plain gable roof can be determined by multiplying the number in the last column by both the length and width of the building and adding thereto the area of the projecting eaves and gables. The areas of roofs broken by dormers and such can be found in a similar manner by determining the area of each part of the roof separately.

When estimating the quantity of roofing needed, allowance should be made for the extra requirements necessary for fitting around chimneys and dormers and at valleys. This will depend on the type and size of the units and the plainness of the roof. In order to get enough material the purchaser should have someone familiar with estimating determine the quantity required.

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